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METHOD OF AND APPARATUS FOR UTILIZING WASTE HEAT

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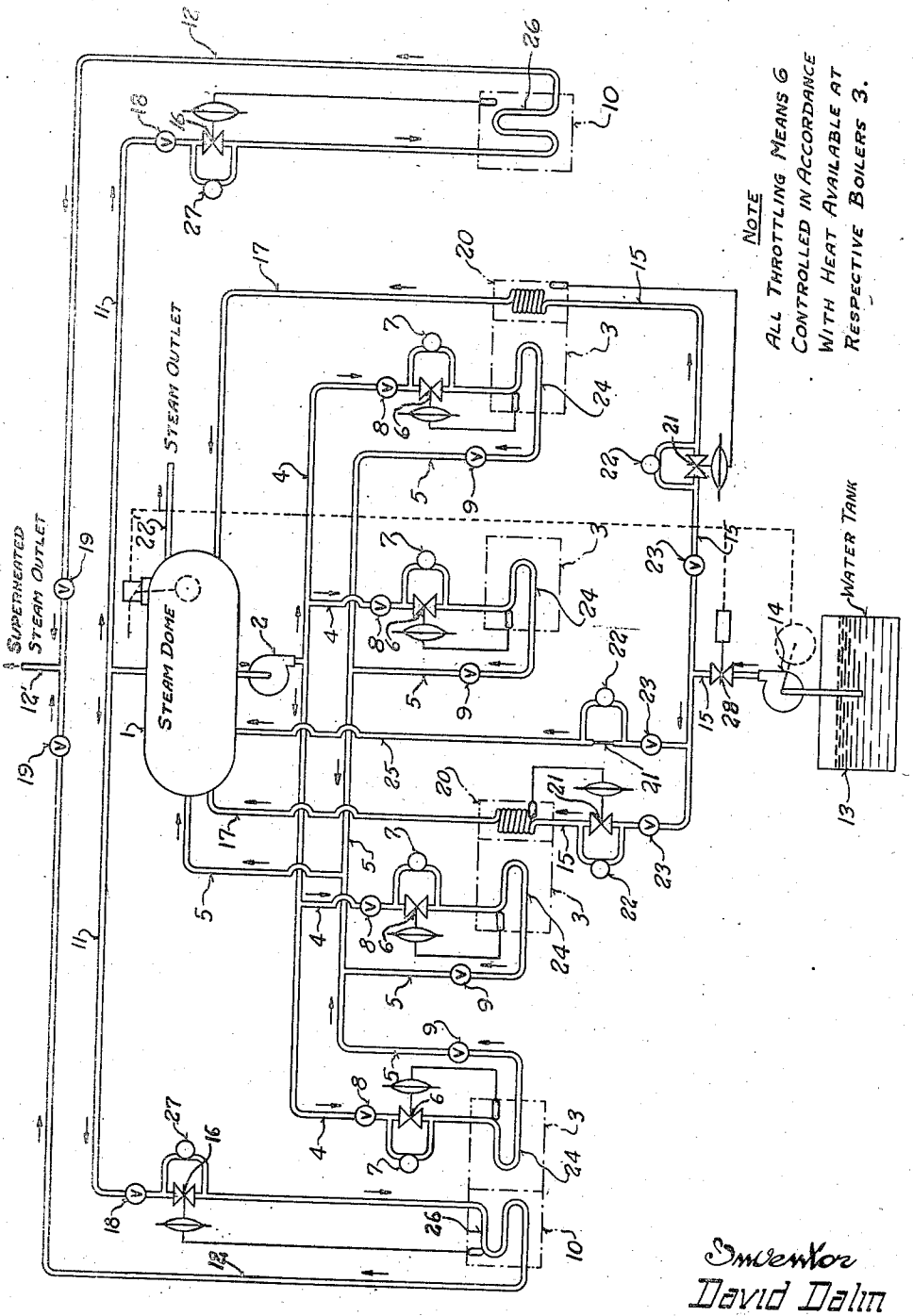

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METHOD OF AND APPARATUS FOR UTILIZING WASTE HEAT

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This invention relates to improvements in the generation of steam and has as its object to provide a method or system of steam generation whereby much of the heat ordinarily wasted in the operation of large industrial plants is put to effective use. In the operation of many industrial plants, as for instance in the iron industry and the slate oil industry, much heat in the form of exhaust flue gases, radiation, etc., goes to waste. In such industries the sources of heat are numerous but invariably located at considerable distances from each other and scattered widely throughout the entire plant.

With a view toward utilizing this ordinarily wasted heat, this invention has as its object to provide a steam generating system consisting essentially of a number of wholly independent steam generators each located at one of the sources of ordinarily wasted heat but all connected with a common steam dome in which the steam generated is accumulated and from which a steam-water emulsion is circulated through all of the several steam generators.

More specifically it is an object of this invention to provide a new and more economical method and apparatus for generating steam whereby much of the heat ordinarily wasted at a plurality of widely scattered heat sources, as for instance the many retorts and furnaces employed in many industrial plants, is utilized through the provision of a plurality of separate steam generators of the positive circulation type all connected with a common steam dome into which the feed water is introduced directly or through an economizer and from which a water-steam emulsion is positively circulated through the individual steam generators in accordance with the requirements of each individual generator.

Each individual steam generator may consist of one or more boiler units or groups of units, and inasmuch as the circulation requirements of each generator will vary and the location of the generators and their distances from the common steam dome and circulating pump varies with different installations, it is another object of this invention to so regulate the flow through the various generators that the minimum quantity (by weight) of water circulated through each boiler or generator is three to fifteen, preferably four to eight times the quantity (by weight) of the steam produced at the respective boilers or steam generator, to thus afford adequate protection against local overheating of the tubes of the steam generators.

The achievement of this desideratum is brought

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about through the use of suitable constrictions at the inlet of each steam generator whereby a predetermined pressure drop is effected. These constrictions may be in the form of throttle discs mounted in the lines at the inlets of the steam generators and provided with fixed orifices of a predetermined or pre-set size to maintain the desired water-to-steam ratio; or they may be adjustable constricting devices controlled by suitable temperature responsive means mounted to be acted upon by temperature changes at the heat sources.

With the above and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described, and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawing illustrates a complete example of the physical embodiment of the invention constructed in accordance with the best mode so far devised for the practical application of the principles thereof, and in which the single figure diagrammatically illustrates one adaptation of this invention.

Referring now more particularly to the accompanying drawing, in which like numerals indicate like parts, the numeral 1 designates a steam dome from which a water-steam emulsion is positively circulated by a force pump 2 to all of a plurality of individual boilers or steam generators 3, it being understood that the diagrammatic illustrations generally designated by the numerals 3 include the heat sources of the boilers or steam generators. It should also be understood that each steam generator 3 may consist of only one or a group of individual boilers.

These boilers or steam generators are located at widely scattered places throughout the industrial plant in which the system is installed, with the coils or heat exchangers 24 thereof so disposed as to utilize the ordinarily wasted heat emanating from the various heat sources. This widely scattered distribution of the steam generators, of course, introduces great variations in the factors determining flow through the coils of the boilers.

The different lengths and different resistances of the pipe conduits, the resistances to flow caused by the different shapes of the boiler tubes and the dimensions thereof, and the varying heat absorption of the circulating water are examples

of the factors which determine flow through the various boilers.

Assurance that each boiler will at all times receive at least the minimum quantity of water consistent with good practice, thus introduces difficulties. These difficulties are successfully met in the present invention through the provision of proper throttling means 6 incorporated in the inlet lines or conduits 4 by which the steam generators are connected to the outlet side of the force pump 2. These throttling means control the flow of steam-water emulsion to the coils 24 and back through return lines 5 to the steam dome.

The throttling means 6 may be fixed constrictions in the inlets of the various boilers or groups of boilers with orifices of a size predetermined or pre-set to maintain a given steam-water ratio in the emulsion flowing through the boiler units controlled thereby. With the size of the orifices properly determined, the distribution of the water to the various boilers will be in such relationship to the heat absorbed by the boiler water circulating through the boiler tubes that good efficiency compatible with safety will be assured.

To obtain best results, the quantity of water circulating through the boilers should be three to fifteen and preferably four to eight times as large as the quantity of steam produced, both measured by weight; and in order to achieve stability in the distribution of the water throughout the entire system, the energy absorbed by each throttle means 6 should correspond to approximately three tenths (.3) to two (2) kilograms per square centimeter, though a pressure drop of one (1) kilogram per square centimeter has been found best for practical purposes.

While the throttling means 6 may be of the pre-set fixed variety described they also can be automatically regulated in accordance with the heat available at their respective boilers or steam generators. Any suitable conventional control means for accomplishing this purpose may be employed as, for instance, thermostatically actuated valves adjusted by the expansion and contraction of a fluid contained within a control bulb located at the heat source.

In any event, it is desirable that the operator know the quantity of water passing to each boiler and to this end measuring means, which may consist of differential pressure gauges communicating with the inlet lines or conduits 4 at opposite sides of the throttling means, are provided.

As will be readily apparent, the individual control of the circulation through the several boilers or steam generators enables practically an unlimited number of such boiler units to be employed without regard to disparity in sizes and heat absorbing capacities, nor does the fact that the individual boiler units may be located comparatively great distances from each other and from the common steam dome affect the safe and effective operation of the entire system.

Inasmuch as it may be desirable at times to disconnect one or more of the boiler units, cut-off valves 8 and 9 are provided in the inlet and return lines 4 and 5 respectively.

Feed water is supplied to the steam dome from a water source 13 by means of a force pump 14, the discharge of which is controlled by a feed water regulator valve 28 governed in any suitable manner by the water level in the steam dome. For instance, as illustrated in the drawing, a float controlled switch may be provided to regulate the operation of an electrically actuated mechanism controlling the regulator valve 28 and also the pump 14.

The feed water may be conducted directly into the steam dome through a conduit 25 connecting with the outlet side of the regulator valve 28, or it may be introduced into the steam dome through conduits 17 which have economizers 20 connected therein. In the latter case the feed water is conducted to the economizers through conduits 15 in which throttling means 21 are incorporated. These throttling means may be similar to the throttling means 6, and control the flow to the economizers in accordance with the heat available thereat. Flow meters or gauges 22 are also preferably connected in the conduits 15 to visually indicate the quantity of water flowing to the economizers, and to permit any one or more of these feed water paths to be cut off entirely, valves 23 are provided.

As shown, the direct line 25 carrying the feed water to the steam dome also incorporates throttling means 21, a gauge 22 and a cut-off valve 23, but in this case the throttling means may be manually pre-set.

In any event it is to be observed that the maintenance of an adequate water level is assured at all times. For ordinary purposes the amount of water contained within the steam dome should be approximately half its capacity.

The steam generated and accumulated in the steam dome may be drawn off directly through the steam outlet duct 22' or it may be conveyed through conduits 11 to the heat absorbing surfaces or coils 26 of superheaters 10 two of which are shown, one associated with one of the boiler units 3 and the other heated by an independent heat source. The steam issuing from the superheaters is fed to a consumption conduit 12'.

Like the boiler units 3, these superheaters 10 are located at convenient heat sources regardless of their location in the plant, to absorb ordinarily wasted heat. As in the case of the boiler units 3, the flow through the superheaters is controlled in accordance with the available heat thereat by means of throttling valves 16 operated by a control responsive to the heat at the heat sources, and to provide visual indication of the flow through each superheater a suitable measuring means 27 is connected in each branch of the duct 11.

Either or both superheaters may be cut out of the system by means of cut-off valves 18 and 19 in the feed and return lines 11 and 12, respectively.

From the foregoing description, taken in connection with the accompanying drawing, it will be readily apparent to those skilled in the art that this invention effectively utilizes much of the heat ordinarily wasted in the operation of industrial plants, and that the apparatus by which it accomplishes this desideratum is sufficiently flexible to accommodate all the varying operational characteristics which might be met in different industrial plants.

What I claim as my invention is:

1. A method of utilizing waste heat available at a plurality of widely scattered heat sources, comprising: placing a steam boiler in heat transfer relation to each of such heat sources; positively circulating boiler water through all of said boilers from and back to a common steam dome; regulating the flow of the boiler water circulating through each boiler to maintain at least three times as much (by weight) water circulating

through each boiler as the amount (by weight) of the steam generated thereat; withdrawing for use the steam accumulated in the common steam dome; and feeding water into the steam dome to compensate for the steam withdrawn and maintain a predetermined water level in the steam dome.

2. A steam generating plant wherein the heat for the generation of the steam is derived from a plurality of widely scattered heat sources, comprising: a plurality of individual boilers of the water tube positive circulation type, each located at a different one of the heat sources and arranged to utilize the waste heat thereat; a steam dome common to all of said boilers; inlet and outlet conduits connecting each boiler with the steam dome for circulating a water-steam emulsion from the steam dome, through each boiler and back to the steam dome, so that the steam generated at all of the individual boilers is accumulated in said steam dome; means for effecting forced circulation of the steam and water emulsion through said boilers from, and back to, the steam dome; and means for regulating the flow through each boiler to insure an excess of water circulating through the boilers adequate to safeguard the boilers against local overheating.

3. A steam generating plant wherein the heat for the generation of steam is derived from a plurality of widely scattered heat sources, comprising: a plurality of individual boilers each located at a different one of a number of the heat sources and arranged to utilize waste heat thereat; a steam dome common to all of said boilers; a force pump having its inlet connected with the steam dome below the normal water level therein; inlet ducts leading from the discharge side of said force pump to all of the boilers; outlet ducts connecting each boiler with the steam dome, so that said force pump effects forced circulation of water from the steam dome through all of the boilers; and flow constricting means for each boiler whereby the flow through each boiler is maintained sufficient to have at all times at least three times as much water flowing through the tubes of each boiler as the amount of steam produced thereat, both the water and steam quantities being measured by weight.

4. A system of utilizing waste heat available at a plurality of widely scattered heat sources, comprising, in combination: a plurality of wholly disassociated individual gaseous fluid heaters, each located at one of the heat sources; a single collecting chamber for a fluid medium to be heated at said gaseous fluid heaters; inlet and outlet conduits connecting each of said gaseous fluid heaters with said single collecting chamber so that the medium being heated may circulate from said collecting chamber through all of said gaseous fluid heaters; means for effecting such circulation of said medium through said gaseous fluid heaters; means for regulating the flow through each gaseous fluid heater in accordance with the requirements thereof and the ability of the fluid medium to absorb the available waste heat thereat; and means for automatically maintaining a predetermined volume of the medium being heated in said common collecting chamber.

5. A steam generating plant comprising: a plurality of individual boilers of the water tube positive circulation type, each located at one of a number of widely scattered independent heat sources the main purposes of which are other than the firing of said boilers, so as to utilize the waste heat at such sources; a single steam dome; inlet and outlet conduits connecting each boiler with the dome for circulating a water-steam emulsion from the steam dome through each boiler and whereby the steam generated at all of the individual boilers is accumulated in said dome; means for effecting forced circulation of the steam-water emulsion through each of said boilers from and to the steam dome; and means for regulating the flow from the dome to each boiler in accordance with the requirements of the boiler.

6. A steam generating plant comprising: a plurality of wholly disassociated individual boilers of the positive circulation type; a separate heat source for each of said boilers; a single steam dome; inlet and outlet ducts connecting each boiler with said dome so that the steam generated at all of the individual boilers is accumulated in said dome; a pump having its inlet connected with the dome to take water therefrom and having its outlet connected with all of the inlet ducts leading to the boilers so that the pump positively circulates water from the dome through all of the boilers; and means for adjusting the flow through each boiler so as to maintain at least three times as much water flowing through each boiler as the amount of steam produced thereat, both quantities being measured by weight.

7. A steam generating plant comprising: a plurality of wholly disassociated individual boilers of the positive circulation type; a separate heat source for each of said boilers; a single steam dome; inlet and outlet ducts connecting each boiler with said dome so that the steam generated at all of the individual boilers is accumulated in said dome; a pump having its inlet connected with the dome to take water therefrom and having its outlet connected with all of the inlet ducts leading to the boilers so that the pump positively circulates water from the dome through all of the boilers; and throttling means in the circuit of each boiler adjusted to effect a pressure drop of between three tenths (.3) and two (2) kilograms per square centimeter in the steam-water emulsion circulating through each boiler.

8. A steam generating plant comprising: a plurality of wholly disassociated individual boilers of the positive circulation type; a separate heat source for each of said boilers; a single steam dome; inlet and outlet ducts connecting each boiler with said dome so that the steam generated at all of the individual boilers is accumulated in said dome; a pump having its inlet connected with the dome to take water therefrom and having its outlet connected with all of the inlet ducts leading to the boilers so that the pump positively circulates water from the dome through all of the boilers, said pump having a delivery in excess of that required to simultaneously circulate water through all of the boilers; throttling means in the circuit of each boiler adjusted to effect a pressure drop of between three tenths (.3) and two (2) kilograms per square centimeter and to maintain at least three times as much water flowing through the boiler as the quantity of steam produced thereat, both measured by weight; and shut-off valves in the inlet and outlet ducts of each boiler whereby any one or number of boilers may be disconnected from the system.

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